Changes in accessibility to foodbanks during COVID-19 and implications for the food security of vulnerable populations in Hamilton, Ontario

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Abstract

This is the abstract.

It consists of two paragraphs.

CRediT author statement

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Introduction

Food insecurity is defined as an "inadequate or uncertain access to a sufficient quantity and/or adequate quality of food" due to a household's financial limitations (Enns et al., 2020). This condition has been associated with reductions in nutritional outcomes (Bhattacharya et al., 2004; Kirkpatrick and Tarasuk, 2008; Olson, 1999) and physical and mental health in children and adults (Elgar et al., 2021; Jones, 2017; Ramsey et al., 2011; Seligman et al., 2010; Stuff et al., 2004). Over at least the past four decades foodbanks have become an essential line of defense against food insecurity in Canadian communities (Black and Seto, 2020; Holmes et al., 2018; Riches, 2002; Tarasuk et al., 2020). In this respect, Canada is not unlike numerous other wealthy countries where a systematic dismantling of the welfare state took place in the intervening period (Tarasuk et al., 2014).

The emergence of COVID-19, the worst public health crisis since the 1918 flu pandemic, has revealed important social and economic fault lines, and preexisting patterns of inequality appear to have been exacerbated. Along several other dimensions of stress (e.g., accessibility to health care facilities, Pereira et al., 2021a), this seems to be the case for food insecurity as well (Laborde et al., 2020). In the US, for example, it has been estimated that there was an increase of more than 30% in household food insecurity, and more than one third of households were discovered to be newly food insecure - meaning they did not experience food insecurity before the pandemic (Niles et al., 2020). In Canada, Men and Tarasuk (2021) report that about 25% of individuals who experienced job insecurity (a relatively common occurrence during the pandemic), also experienced food insecurity. Similarly, according to Statistics Canada (2020a), in the early stages of the pandemic almost 15% of individuals reported living in a household that faced food insecurity; the risk of food insecurity was substantially higher for households with children. The difference between households with and without children was significant, and 11.7% of households with children indicated that "food didn't last and [there was] no money to get more" sometimes or often, compared to 7.3% of households without children; likewise, 13% of households with children indicated that they "[c]ouldn't afford balanced meals" sometimes or often, compared to 8.8% of households without children.

The impacts of food insecurity during the pandemic are alarming, since diet-related diseases, such as obesity, heart-disease, and diabetes, were already critical public health concerns in Canada prior to COVID-19 (Boucher et al., 2017). While foodbanks are not necessarily a stable solution to food insecurity and in fact may encourage a retrenchment of neoliberal policy (Wakefield et al., 2013), at least they can be argued to provide a resource of last instance to households in precarious situations (Bazerghi et al., 2016). As recently as 2019, the Hamilton Hunger Report[1] noted that foodbanks in Hamilton, Ontario,

[1] https://www.hamiltonfoodshare.org/wp-content/uploads/Hamilton-Food-Share-Hunger-Report-2019.pdf

recorded the highest number of visitors in the past 29 years; the number of children visiting foodbanks (minors up to 18 years old) was 9,125 in March 2019, up from 8,278 the year before, a rate of increase greater than population growth.

It is known that urban food environments, within which people make their daily food choices, are essential in influencing eating behaviours and health outcomes, based on factors such as food availability, ease of geographic accessibility and socio-demographic variations (Paez et al., 2010; Vanderlee and L'Abbé, 2017; Widener, 2018). However, while there is a wealth of literature that has examined the topic of geographic accessibility to healthy food through the "food desert" concept, there has been little research into accessibility to foodbanks. Although previous work has explored differences in *accessing* foodbanks, such as how some households utilize foodbanks over short periods of time while others regularly utilize foodbanks as longer-term resource (e.g., Enns et al., 2020), we are not aware of any research that has focused on the geographic component of accessibility.

The study of place-based geographic accessibility is concerned with capturing the potential to reach destinations of value using the transportation network (Páez et al., 2012). Indeed, the Government of Canada's recent Food Policy has made "access" to healthy food a priority for Canadian communities[2] and previous survey research has suggested that such accessibility plays a key role in user satisfaction with foodbank service delivery (Holmes et al., 2018). However, as with research into the prevalence of food deserts, accessibility to foodbanks is unlikely to be evenly distributed, and variation throughout a city can be expected due to transportation network characteristics, and the spatial distribution of foodbank locations and the population they are meant to serve. Furthermore, policy responses to the COVID-19 pandemic likely have added to the distress of vulnerable households. Non-pharmaceutical interventions during the pandemic involving restrictions in mobility have increased the friction of travel, in particular by transit on which low income populations are more reliant (e.g., DeWeese et al., 2020). At the same time, the pandemic has created additional stress for the operators of foodbanks through disruptions in the supply chain (e.g., McKay et al., 2021) as well as concerns surrounding the delivery of service in safe conditions and possible cancellation of food service programs.

For this study, we aim to look at how the landscape of foodbanks and related services (e.g. low-cost or free meal service providers) available in Hamilton, Ontario, changed during the pandemic. Did the number of open foodbank services diminish? If so, what was the accessibility to foodbanks before the pandemic from the perspective of low income households, and how it changed during the pandemic? And finally, who are most likely to have been impacted by changes in the accessibility landscape? This paper first looks at the distribution of foodbanks and related services before and during the pandemic. Then, we

[2]https://www.agr.gc.ca/eng/about-our-department/key-departmental-initiatives/food-policy/the-food-policy-for-canada/?id=1597863791042

use the balanced floating catchment area approach of Paez et al. (2019) to investigate the accessibility situation. For this, we use a fully disaggregated approach based on parcel-level data. Socio-economic and demographic data are drawn from the latest Census of Canada (2016), whereas travel information is from the most recent regional travel survey from 2016. This paper follows reproducible research recommendations (see Brunsdon and Comber, 2020), and the research was conducted using open source tools for transportation analysis (Lovelace, 2021). The code and data necessary to reproduce the analysis are available in a public repository[3].

Food Insecurity and foodbank Use in Canada

Food insecurity is the inability to acquire and consume an adequate amount or good quality food, leading to inadequate nutrient intake (Enns et al., 2020; Kirkpatrick and Tarasuk, 2008; Tarasuk and Vogt, 2009). This nutrient deficiency is associated with major population health concerns, particularly among Canadians at socio-economic disadvantage (Bazerghi et al., 2016). Data on food insecurity in Canada is collected in several ways. Quantitatively, official government surveys such as the Household Food Security Survey Module (HFSSM), the Canadian Community Health Surveys (CCHS), the International Study of Adults (LISA), and official classifications determined by Health Canada in relation to socio-demographic variables offer some insight into food insecurity (Gundersen et al., 2018; Kirkpatrick and Tarasuk, 2008; Tarasuk and Vogt, 2009). Nationally, it has been found that food insecurity impacts approximately 12.3% of Canadian households (Tarasuk et al., 2014)

Foodbanks - sometimes also referred to as 'food pantries' and 'food shelves' - originated as a community response to aid those with inadequate food by voluntarily offering them meals and ingredients (Loopstra and Tarasuk, 2012; Riches, 2002). The scope and objectives of foodbanks can vary by region and by country, and these organizations can include not only prepared meals and aliments, but also shared spaces to connect in community gardens and community kitchens (Wakefield et al., 2013). Although in their origin foodbanks were meant to be provide a temporary solution to accommodate those in hunger due to job retrenchments and economic downfalls since the 1980s, over time they have evolved into a community practice to secure emergency food supplies for those in need (Loopstra and Tarasuk, 2012; Wakefield et al., 2013).

In Canada, the number of foodbanks has steadily increased in the past few decades (Wakefield et al., 2013). The largest database of foodbanks and their use comes from the non-profit association Food Banks Canada (FBC), which conducts an annual assessment through its affiliated members. FBC's 2018 Hunger Count report[4] (the most recent available) listed 1,830 member foodbanks across

[3] add repository

[4] https://foodbankscanada.ca/getmedia/241fb659-05f5-44a2-9cef-56f5f51db523/HungerCount-2018_FINAL_EN.pdf.aspx?ext=.pdf

the country, and found that Canadians visited foodbanks 1.1 million times in March of 2018. Of those accessing foodbanks, certain population characteristics tend to be over-represented compared to national totals from the 2016 Canadian Census of Population. According to FBC's 2018 data, single-adult households represent 45% of those utilizing foodbanks despite making up 28% of Canada's population, 19% are single-parent households (compared to 10% nationally), and 35% of those accessing foodbank services are children aged 0-18 even though their share of Canada's national population is approximately 20%. In addition, 59% of households accessing foodbanks list social or disability assistance as their primary source of income. Similarly, using data from the 2011-2012 CCHS, Tarasuk et al. (2019) found higher odds of food insecurity amongst households relying on social assistance, those without a university degree or with children under the age of 18, and individuals that lived alone, renters, and those identifying as Aboriginal. While surveys revealed that only 20 to 30 percent of those experiencing food insecurity were found to frequent foodbanks in Canada (Tarasuk et al., 2014), research from Ottawa (Enns et al., 2020) and Vancouver (Black and Seto, 2020) suggests that long-term users tend to be older, have health or mobility challenges, live in large households, and are less likely to have employment income.

Economic stress caused by the COVID-19 pandemic, rising unemployment rates, and changes in poverty levels have disrupted the food environment and led to higher rates of food insecurity (Niles et al., 2020). Pandemic-related food security studies in the US have found a substantial increase in households experiencing food insecurity for the first time, and also in households experiencing more severe food insecurity than before (Niles et al., 2020; Wolfson and Leung, 2020). Most recently in May 2020, Canada recorded 14.7% of its population living in food insecurity in the past 30 days (Statistics Canada, 2020a). Considering the negative mental and physical health effects associated with food insecurity, increases in food insecurity rates due to the pandemic, signal a change in the food environment with potential damages to population health during the course of the pandemic and beyond (Niles et al., 2020). Recent data[5] from FBC showed that 52% of member foodbanks reported an increase in usage in March of 2020 when initial lockdown restrictions were put in place across much of the country. The pandemic also created significant staffing issues with 42% of foodbanks reporting a reduction in volunteers. However, 53% of foodbanks later reported a decrease in use into the summer of 2020 which FBC members attributed to emergency financial support programs from the federal government. Nevertheless, some of these benefit programs were temporary, which suggests that many households may again turn to foodbank services to meet their needs.

In terms of geography, previous research conducted at the provincial scale using data from the 2011-2012 CCHS found that the prevalence of food insecurity ranged across the country from 11.8% of households in Ontario to 41%

[5]https://www.foodbankscanada.ca/FoodBanks/MediaLibrary/COVID-Report_2020/A-Snapshot-of-Food-Banks-in-Canada-and-the-COVID-19-Crisis_Exec-Sum_EN.pdf

of households in Nunavut (Tarasuk et al., 2019). However, although previous research has examined the characteristics of individuals and households accessing foodbanks, the locational or transportation accessibility aspect of foodbank access is not well understood. A wealth of literature examining the food desert concept suggests that, in addition to socio-economic and demographic factors, location and transportation networks play a key role in a household's accessibility to healthy foods (Paez et al., 2010; Vanderlee and L'Abbé, 2017; Widener, 2018). For foodbanks specifically, previous qualitative research by Smith et al. (2017) in Ontario has noted that participants access foodbanks using a variety of modes of transportation and that some food bank users have expressed difficulties with transportation for trips to foodbank locations, with one respondent stating "I wish it [the foodbank] was a little more centrally located. Because if I didn't have a bike I'd have to walk it all the way out there and back. I wonder about people who don't." From this, the authors conclude that "transportation can be challenging, particularly if the foodbank is situated in a remote location." To offer greater insight into the role of transportation and location in foodbank accessibility, this research examines how geographic accessibility to foodbanks and food services changed in Hamilton during the COVID-19 pandemic.

Methods and Materials

Methods

For the research in this paper we adopt the balanced floating catchment area approach of Paez et al. (2019). This method for estimating accessibility is a form of the widely-used two-stage floating catchment area method (Luo and Wang, 2003; Radke and Mu, 2000). Floating catchment areas are used to estimate accessibility when there are potential congestion effects, and operate by calculating first the *demand* for spatially distributed services. The demand (usually the number of people who require a service) is used to calculate a level of service. In a second step, the level of service is allocated back to the population. Demand and level of service are allocated using some form of distance-decay to embody the geographical principle that, given a choice, people prefer to travel less than more when reaching destinations.

More formally, the first step of this method is as follows:

$$L_j = \frac{S_j}{\sum_{i=1}^{n} P_i w_{ij}}$$

where S_j is the level of supply at location j, in simplest terms whether a service point is present (i.e., $S_j = 1$) or not (i.e., $S_j = 0$); P_i is the population at location i that demands the service; and w_{ij} is a weight, typically a function of the distance between locations i and j. L_j is the level of service at location j and it is the inverse of the number of people that need to be serviced.

The second step in this process is then summing the level of service that each population unit can reach, according to the distance-decay weight:

$$A_i = \sum_{j=1}^{J} L_j w_{ji}$$

where A_i is the accessibility to the service, which is in the same units as the level of service: as the inverse of the population being serviced. When the population being serviced is low accessibility is high (i.e., there is little competition for the service), and viceversa.

Floating catchment area methods are prone to overestimation of the population and the level of service due to multiple-counting. The population at P_i is allocated to *every* service point j for which $w_{ij} > 0$. Similarly, the level of service at LOS_j is allocated to *every* population point for which $w_{ji} > 0$. This inflation effect has been known for several years, and several modifications have been proposed to mitigate it (Delamater, 2013; e.g., Wan et al., 2012). A definitive solution to this issue was presented by Paez et al. (2019). In order to avoid the multiple-counting in the summations, the population and the level of service need to be allocated *proportionally*. This is achieved by standardizing the weights as follows:

$$w_{ij}^{\text{st}} = \frac{w_{ij}}{\sum_{i=1}^{n} w_{ij}}$$

and:

$$w_{ji}^{\text{st}} = \frac{w_{ji}}{\sum_{j=1}^{J} w_{ji}}$$

The standardized weights satisfy the following conditions:

$$\sum_{i=1}^{n} w_{ij}^{\text{st}} = 1$$

and:

$$\sum_{j=1}^{J} w_{ji}^{\text{st}} = 1$$

Since the population is allocated proportionally, its value is preserved:

$$\sum_{i=1}^{n} P_i w_{ij}^{\text{st}} = P_i$$

as is the level of service:

$$\sum_{j=1}^{J} L_j w_{ji}^{\text{st}} = L_j$$

Data

Data have been prepared for sharing as a data package[6]. The contents of the data package are described next.

Statistics Canada

Population and income statistics for 2016 were retrieved at the level of Dissemination Areas (DAs) using the package `cancensus` (von Bergmann et al., 2021). DAs are the smallest publicly available census geography in Canada. Income data corresponds to the count of households by different total income groupings.

Origins: Residential parcels

We converted all recorded residential land parcels in the City of Hamilton to points on the road network. Each point includes information about the number of residential units in the parcel. Next, we define low-income households as those having a total income of less than CAD40,000, which is approximately the mid-point of the low income cut-off (LICOs) for families in Canadian cities with populations greater than 500,000 in 2016, to match other Census data (Statistics Canada, 2020b). We then "populate" each residential unit with the probability of being a low-income household based on the counts of households by income groups in the DA in which the parcel is located. While this method assumes a constant probability of low-income household status for all residential units in a DA, the parcel-level analysis affords a high level of spatial disaggregation for the accessibility analysis.

Destinations: foodbanks and Food Service Locations

The locations of foodbanks and related food services were obtained from the Hamilton Public Library's Food Access Guide[7]. The guide was updated in April of 2021 to indicate any change affected on the services due to the pandemic. This includes modified business hours, a need to make reservations before frequenting, and locations that have completely shut down in consequence. While some foodbank services have a specific a target population, such as prioritizing family with young children aged between 0 and 3 or accepting only those providing proof of low-income status through housing and utility statements, all the foodbank services indicated below are designed to accommodate those in need of food at zero to low cost. With our focus on foodbanks and food services that offer free or low-cost meals at particular locations, we first removed services such as Meals on Wheels and other food access services such as food box, community kitchens, student nutrition programs, and shopping and transportation. In addition, two free meal services held on different days at the same location were collapsed into a single service point for the accessibility analysis.

[6] add repository

[7] http://foodaccessguide.ca/sites/default/files/partnersites/pdf/foodaccessguide.pdf

Table 1: foodbank and Food Service Information.

Type	Description	Locations Pre-COVID	Locations During COVID	Additional Notes
Congregate Dining	Congregate and dining programs provide low-cost meals that are enjoyed in a community setting. Transportation may be provided	7	2	One remaining location reduced hours during COVID
Community Meals	Programs often run by volunteers that organize suppers, lunches or other get-togethers that give community residents an opportunity to meet one another in a friendly and informal atmosphere while sharing a meal	11	9	NA
Food Banks	Food Banks and Emergency Food programs provide individuals and families with grocery items free of charge	27	26	One remaining location reduced hours during COVID while 4 others moved to appointment only
Free Meals	Meals are provided free of charge in the community through volunteer labour and donations	9	5	One remaining location reduced hours during COVID
Low-Cost Meals	Restaurants, cafeterias and other eating establishments operated by hospitals, senior centers or other organizations which provide reduced-cost meals for low-income people, older adults or other targeted individuals.	2	1	The remaining location reduced hours during COVID

Routing and travel time tables

Travel time tables for three modes (car, transit, walking) were computed using the parcels as the origins and the locations of the foodbanks as the destinations. For routing, the package `r5r` (Pereira et al., 2021b) was used with a network extract for the City of Hamilton from OpenStreetMaps and the General Transit Feed Specification from Hamilton Street Railway, the local transit operator. For routing purposes we used maximum values of 180 min and 10,000 m walking distance: any destination that exceeded these thresholds was ignored. The departure time used for routing was **TIME**.

Transportation Tomorrow Survey

We used the Data Retrieval System of the Transportation Tomorrow Survey (TTS)[8] to download cross-tabulations of: 1) primary mode of travel per trip by income by place of residence; and 2) age by income by place of residence. These data are from the 2016 Survey (the most recent available), and data are geocoded at the level of Traffic Analysis Zones (TAZ) using the most recent zoning system from 2006. Each parcel point is populated with the proportion of trips by three modes of travel: car (as driver or passenger), transit, and walk.

Expected Travel Times

Once we obtained travel time tables with population (number of households) and proportion of trips by mode, we calculated the expected travel time *ett* from each parcel i to a foodbank or food service location j as follows:

$$ett_{ij} = p_i^c \cdot tt_{ij}^c + p_i^t \cdot tt_{ij}^t + p_i^w \cdot tt_{ij}^w$$

[8] http://dmg.utoronto.ca/

where p_i^k is the proportion of trips by mode k in the TAZ of parcel i, and tt_{ij}^k is the travel time from parcel i to the foodbank. In other words, the expected travel time is the weighted sum of travel times to the foodbank, with the weights given by the expected modal split in the TAZ.

Results and Discussion

Figure 1 shows the location of foodbanks in the City of Hamilton and their status. Before the pandemic there were 58 of which 14 (24.14%) closed during the pandemic. As shown in the figure, foodbanks tend to be predominantly located in the central parts of the city. This is not surprising: population density is high there, and it is also the part of the city where lower income households are more numerous in absolute and relative terms (see Figure 2). Alas, this is also the part of the city where most of the closures during the pandemic happened.

To implement the accessibility calculations, we must select a distance-decay function. In this task we find limited support in the literature, which is mostly silent on the travel patterns of people who visit foodbanks. For this reason, we opt for a simple cumulative opportunities function as follows:

$$w_{ij} = w_{ji} = \begin{cases} 1 & \text{if } ett_{ij} \leq \delta \\ 0 & \text{otherwise} \end{cases}$$

where ett_{ij} is the multimodal expected travel time as described previously, and δ is a travel threshold. When the expected travel time exceeds this threshold, a facility is no longer considered accessible. Further, the weights are standardized for the balanced floating catchment area approach.

Figure 3 shows the results of conducting sensitivity analysis of the system-wide accessibility as we vary the threshold (considering the situation before the pandemic). There is a clear pattern whereby more strict values of δ are associated with higher levels of system-wide accessibility: this is a result of lower congestion, since fewer households are serviced. System-wide accessibility declines with higher values of δ: as more households are serviced, congestion grows and the level of service declines, although this happens at a declining rate. We are not aware of any standards that explain how long people are expected to travel for foodbanks, but we note that in developing countries, access to drinking water is defined as a source that takes less than 30 minutes to reach (round trip, see UNICEF-WHO, 2019). There is no reason why people in affluent countries should be expected to travel more for a basic need such as food. Accordingly, we adopt a threshold of 15 minutes for the analysis (representing a one-way trip). Using this threshold, we find that the system-wide accessibility (interpreted as a provider-to-population ratio) was 0.065 (foodbanks per low income household in the city) before COVID-19, but declined to 0.037 during the pandemic. It is striking that although almost 76% of foodbanks remained in operation during the pandemic, there was a loss of accessibility greater than 43%.

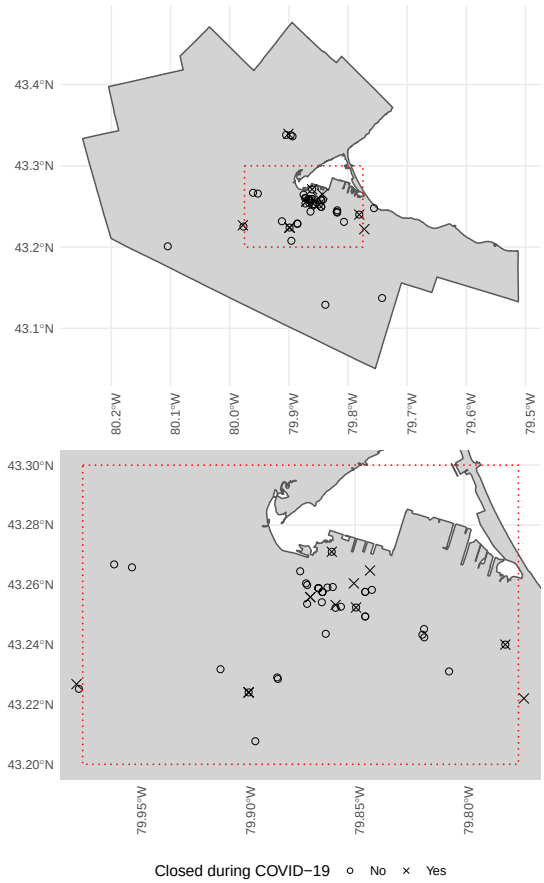

Figure 1: Location of foodbanks and operation status; the dotted box is an inset of the central part of the City of Hamilton

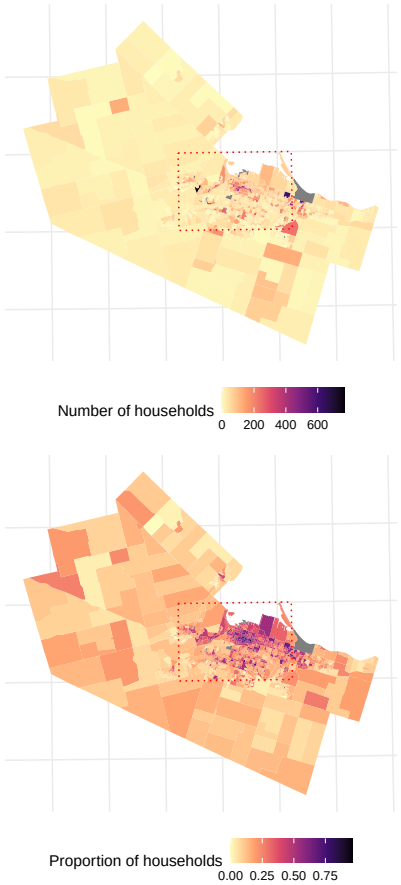

Figure 2: Number and proportion of households with incomes less than CAD40,000.

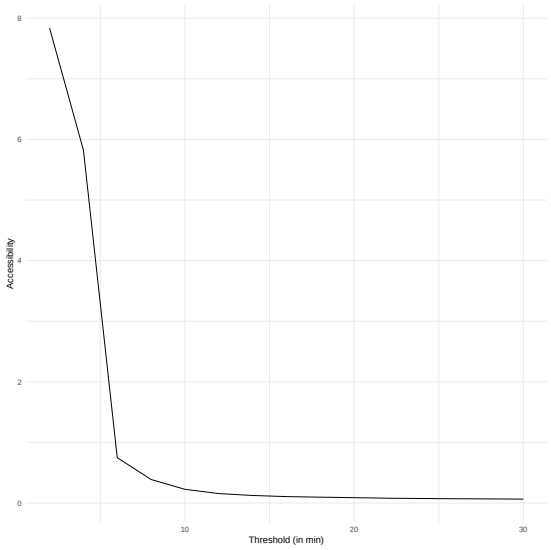

Figure 3: Accessibility as a function of threshold

The levels of service by foodbank before and during the pandemic are shown in Figure 4. Since the level of service is the inverse of the number of households in the catchment area of the foodbanks, higher values mean that a facility is expected to service fewer households. Conversely, lower values indicate grater congestion. The general pattern of the levels of service is similar before and during the pandemic, with lower values in the center of the city. Three more peripheral facilities towards the south of the city also have lower levels of service, presumably because they are meant to service a relatively large suburban/exurban population. During the pandemic, however, the levels of service dropped, in some cases quite substantially. The pattern of the losses in level of service, moreover, is not uniform. Figure 5 shows that the three peripheral facilities in the southern suburban/exurban part of the city had low levels of service to begin with, but did not see major declines during the pandemic. Level of service deteriorated more in the central part of the city, but the loss of level of service was not as large in the core (where most of the foodbanks are), but more marked in the inner ring around the core, where facilities may have faced greater demand from both central city and suburban populations after the closure of foodbanks during the pandemic. To further elucidate this issue, we now turn to the results of the accessibility analysis.

Discuss the results of accessibility.

Discuss the results of aggregating the accessibility by age group (see Table 2). Follow with the analysis of hours of travel?

Figure 4: Levels of service at each facility pre-COVID-19 (top panel) and during COVID-19 (bottom panel).

Table 2: Accessibility by age group among members households with incomes less than CAD40,000.

Population			Accessibility		
Children (age $\leq$ 18)	Adults (19-64)	Seniors (age $\geq$ 65)	Before COVID-19	During COVID-19	Difference
3,445	11,860	6,584	0.00229	0.00173	-0.00057
4,477	12,838	6,847	0.00707	0.00418	-0.00289
3,541	13,189	7,020	0.01580	0.00911	-0.00669
2,340	9,918	4,940	0.03985	0.02202	-0.01783

Note:
Population values have been rounded

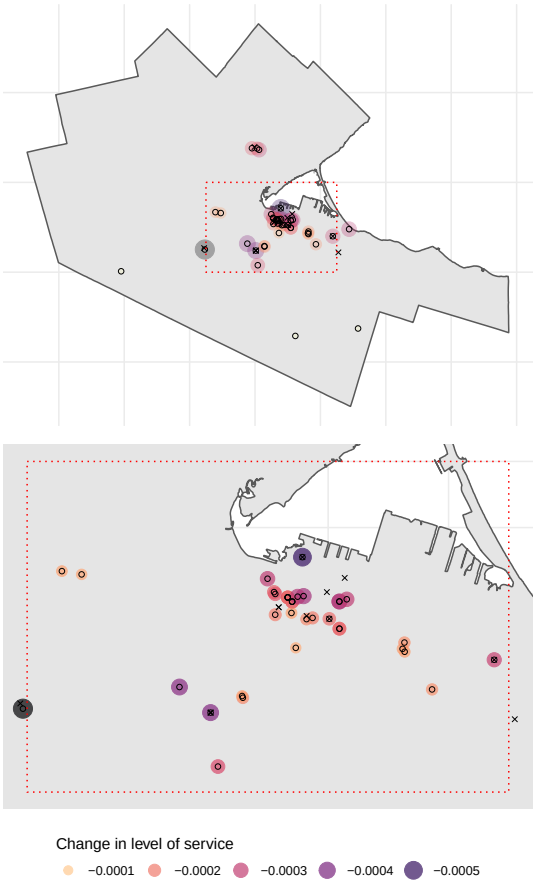

Figure 5: Changes in levels of service at each facility from pre-COVID-19 to during COVID-19.

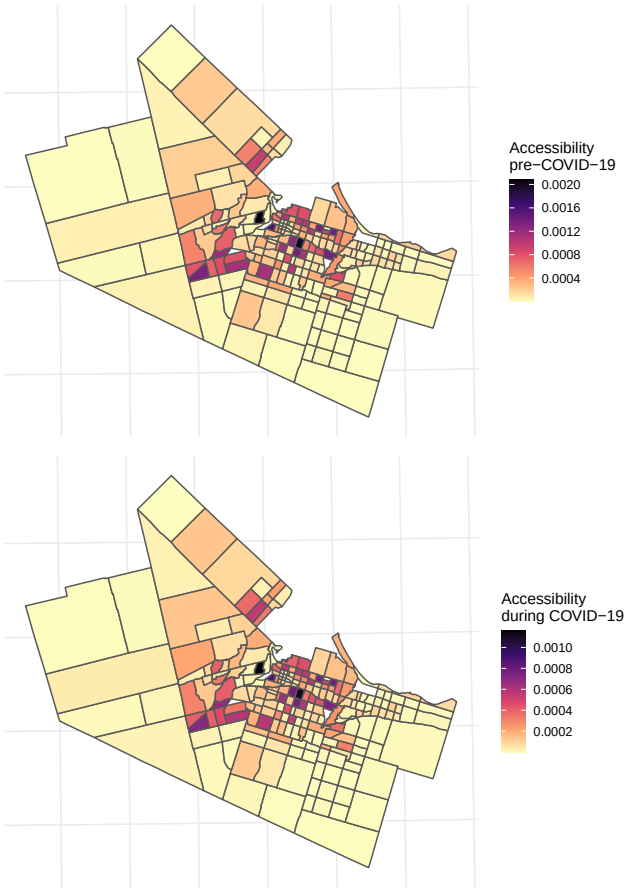

Figure 6: Accessibility by traffic analysis zone pre-COVID-19 (top panel) and during COVID-19 (bottom panel).

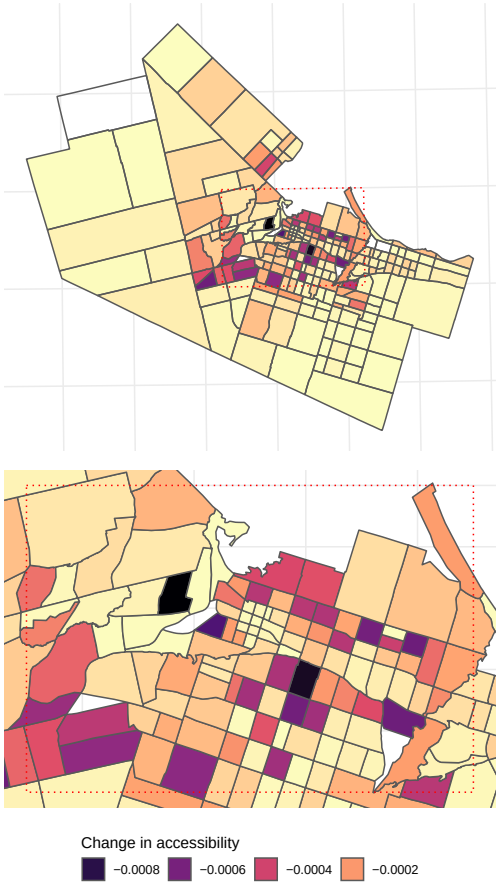

Figure 7: Changes in accessibility from pre-COVID-19 to during COVID-19.

Conclusions

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